OPERATOR'S MANUAL
MOTOR/DRIVER SYSTEMS

P/N 88-002385-01

COMPUMOTOR CORPORATION
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Petaluma, CA 94952

COMPUMOTOR MOTOR/DRIVER SYSTEMS
INSTALLATION & OPERATION MANUAL

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COMPUMOTOR MOTOR/DRIVER SYSTEMS

INSTALLATION AND OPERATION MANUAL

I. INTRODUCTION:

WARNING!

Compumotor Corporation has made a special effort in the design and construction of its products to make them both versatile and easy to use. The mechanical torque produced by these motor/drivers is capable of damaging or destroying the equipment to which they are connected if improperly installed, operated or serviced. Only persons qualified in servicing and installing hazardous voltage electrical and limited-travel mechanical systems should attempt this procedure.

II. INSPECTION

Carefully inspect the shipping carton(s) for any evidence of physical abuse or damage and note any findings on the Waybill at the time of receipt. In cases of severe damage, it is recommended that the shipment be rejected entirely. Compumotor Corporation cannot be responsible for in-transit damage.

II. UNPACKING

Use care in opening the shipping carton(s) so that the cables supplied are not cut or damaged. Verify the receipt of the following items:

Qty	Description
1	Compumotor with 10 foot (3M) Drive Cable
1	Driver (Power Amplifier/Translator) Module
1	3-wire AC Line Cord 6 feet (2M) with Ground Pin
1	Pulse Source Cable Kit
1	Standard Product Line Brochure

Report any shortages and/or direct any questions regarding ordered and supplied options directly to Compumotor Corporation (see Further Questions, Page 7).

IV. MOUNTING THE MOTOR AND DRIVER

The three Series of Compumotor conform to NEMA Standard frame sizes as follows. Outline drawings of the flange mounts got the motors appear as Figures 1 through 4 on the inside of the front cover of this manual.

Compumotor Series	NEMA Standard Frame Size	Bolt Size	Bolt Grade SAE
M57	23	#8-32	3
M83	34	#10-32	3
M106	42	#10-32	3

The Compumotor should be mounted rigidly with the proper size and grade of hardware at all four corners, and the motor case should be connected to third wire ground.

The Compumotor's mounting surface acts as a heat sinking device which carries away thermal energy generated by self heating. Temperatures produced by the motor when not mounted may seem excessive, and are the result of the Compumotor having full power applied at all times, even when not rotating. This heating is normal. The motor temperature will drop considerably when the Compumotor is mounted.

The Driver may be mounted some distance from the motor if the wire lengths and minimum wire sizes listed in Appendix B are observed. Motor cable extensions are available from the factory.

Mount the Driver with the heatsink fins running vertically for best convection cooling (Figure 5). A minimum of 3 inches (7.62 cm) of clearance must surround the Driver on the heatsink top and four sides.

Route the motor cable carefully so that movements of the motor and any attached mechanism(s) will not cause interference. In addition, the motor cable should be routed away form equipment that is sensitive to electro-magnetic interference.

Environmental Considerations:

The mounting location for the Compumotor and driver must be free from all liquids and protected from conductive chips and dust. The standard Compumotor is not suitable for explosive atmostpheres, vacuum beyond 10^{-2} torr, or life-support equipment. The bearings in the motor are not sealed and must be protected from contaminants. Ambient conditions for the Driver are 32 to 122°F (0 to 50°C) and 20 to 90% humidity (non-condensing). The Compumotor can operate from 32 to 150°F (0 to 70°C).

Coil any excess cable at the Driver and secure it with a cable tie. This cable carries high voltage (150 VDC) and all wire runs must conform to all applicable local electrical codes and OSHA requirements. Check that the model number of the Compumotor and the Driver have the same type number (e.g. M83-93). Rotate the Motor Cable Connector until it slips into the mating connector on the Driver. Turn the locking collar clockwise until it is tight.

V. CONNECTING AC POWER*

Select a source of 117 VAC power which is free from line drop outs and transient voltage spikes. The maximum current draw of the various Motor/Driver Systems is listed in Appendix B. Standard practices of sizing wire for these loads must be observed to minimize the voltage drop at the Driver. Appendix C lists isolation transformers for 117 VAC and step-down transformers for use with 230 VAC single phase power.

VI. CHECKOUT

Prior to energizing the Motor/Driver, manually turn the Compumotor shaft by grasping the outer radius of the dummy load. One should feel the magnetic detents characteristic of this type of AC synchronous motor employing permanent magnets.

A. Proper Torque

A dummy load of the approximate inertia listed in Appendix A should be mounted securely to the motor shaft for testing. Only collet-style mounting clamps are recommended for security and for concentricity between the load and the motor shaft. Compumotor Corporation will supply a simple dummy load for the M57 and M83 Series motors upon request. The appropriate part numbers are P/N 53-000536 for the M57 Series and P/N 53-000537 for the M83 Series.

Note: Motor/Drivers with serial numbers above 4,000 have an internal interlock built into the motor cable (Pins 3 and7). The interlock will not allow power to be delivered to the motor connector while the motor is disconnected. This is a safety feature to protect the operator from hazardous voltages that would otherwise be present. It is important that this interlock be supported should an extension or custom cable be used to drive the motor. Consult the factory for assistance prior to making any extension or custom cables.

*Caution: Hazardous voltages inside. Refer installation and servicing to qualified personnel only.

Connect AC power to the Motor/Driver.

It is not unusual for there to be a snap or pop caused by the in-rush energy charging the Motor/Driver power supply. Check that the rated holding torque is present at the Compumotor shaft. This may be done empirically by feel, as the magnetic detent torque will have increased by at least an order of magnitude. A standard torque wrench may be used in place of the dummy load if a quick, quantifiable result is desired. Should the torque under power be low or nonexistent, proceed to Section X, Trouble Shooting (Page 9).

WARNING:

DO NOT connect or disconnect the motor connector while the Motor/Driver is energized because an arc will result in the connector subsequently and damage the Motor/Driver. To do so voids the Warranty. Multiple motors may be connected, one at a time, to the same driver by use of the Remote Power Shutdown and external switches. Consult the factory if this is required.

B. Pulse Source Connection

Prepare the Data Cable Kit according to the following procedures:

Signal	Wire Color Code	Connector Pin No.
Direction Input (+)	Green	A 20 ma, TTL level
Direction Return (-)	White	E
Step Input (+)	Red	B 20 ma, TTL level
Step Return (-)	Black	D
Remote Shutdown (+)	Blue	C 20 ma, TTL level
Shutdown Return (-)	Brown	F
Chassis Ground	Shield (Drain)	Not connected at Driver End

Check the data cable for continuity and possible shorts prior to use. Use a dummy load of 180 ohms to ensure that a minimum of 20 ma is available to drive each of the opto-isolators in the Driver (HP #HCPL 2530).

C. Pulse Generation

Set the pulse rate of your chosen pulse source to zero. Connect the Pulse Source Cable to the Driver. Make sure that the Remote Power Shut-down signal is not asserted (Logical "0" on Pin C).

Compumotors are designed to be accelerated and decelerated. Compumotor Corporation provides a complete line of preset indexers for creating the necessary velocity profiles and controlling total distance moved.

Gradually increase the pulse rate until the dummy load begins to noticeably rotate. Decrease again to zero and change the logic state of the Direction Input. Increase the pulse rate and observe the change in direction of the Compumotor shaft. Return the pulse rate to zero. Simple frequency counters are helpful at this stage to observe velocity changes.

D. Compumotor Pulse Generation

If you are using one of Compumotor Corporation's Preset Indexers with a 25,000 step per revolution Motor/Drive system perform the following test:

150, 170 or 2100 Series Preset Indexers

1. Set the Mode Switch to "Preset".
2. Dial in "10" rev/sec^2 on the Acceleration thumbwheels.
3. Dial in "10.00" rev/sec (150 or 170 Series) or "10.000" rev/sec. (2100) on the Velocity thumbwheels
4. Dial in "+20.000" revolutions on the Position thumbwheels (151 Series) or 500,000 steps (170 or 2100 Series)
5. Depress "START".

If using the 2100 Series Indexer with RS-232C Computer Interface you may do the following:

"E MN A10 V10 D500000 G<CR>" (Carriage Return)

For 2100's exercising the Model 1200 compatibility option the following will have the same results:

Type "MN A10 V10 D20 G (Carriage Return)

All of the above will accelerate the motor at the rate of 10 rev/sec^2 until a velocity of 10 rev/sec. is reached (5 complete revolutions in one second). After completing a total of 15 revolutions, the motor will begin to decelerate at the rate of 10 rev/sec.^{2} to a stop. When stopped, it will have completed exactly 20 revolutions in three seconds.

VII. LIMITED-TRAVEL MECHANISM

Before connecting the actual load to the shaft of the Compumotor, all limited-travel mechanisms must be protected by the use of electrical limit switches. If one of the Compumotor Preset Indexers is used, follow the instructions included with those units. In other cases, a limit switch must signal the need for a controlled deceleration at the maximum rate possible. This rate must be consistent with load inertia and maximum load of the motor.

Note that since the required limits are not the "End-of-Travel" type, they must be tripped far enough before the mechanical stop to allow the load to be safely declerated. This distance may be computed using the Braking Curves of the appropriate Motor Specification Sheet and the formulas given in Application Note #3. It also may be determined empirically be initiating the deceleration cycle in the middle of travel and measuring the distance required to stop.

VIII. DYNAMIC CHARACTERISTICS OF THE COMPUMOTOR

A Compumotor is a special case of a hybrid permanent magnet stop motor driven by a 20 KHz, bi-polar, chopper power amplifier. Its complex wave-shaping circuitry allows significant compensation for many of the mechanical and electrical imbalances inherent in step motors. The digitally-controlled proportioning of current simultaneously between multiple windings gives high torque at low speed without the jarring accelerations of traditional step motors.

The precision of Compumotor's drive proportioning techniques yields exceptional repeatability while maintaining the open-loop accuracy and ease of use characteristic of stepper motors. The Compumotor shares the dynamic response curve of the stepper motor and its stall characteristics. That is, full torque under acceleration is developed at a lag angle of approximately 1.8°. Loading which causes a larger lag angle will result in the motor losing position.

In cases of severe overloading, the rotor will lost synchonism with the rotating magnetic vector of the stator and the rotor will stall and stop. The Compumotor has been designed to allow a continuous stall condition while overloaded without damage to the Compumotor or the driver. If the motor is stalled, however, the rotating magnetic vector must be stopped by halting the input pulses, and the cause of the overload condition remedied before the Compumotor may be restarted and run successfully.

Up to 1.8° of dynamic error under acceleration will be recovered when a constant velocity is reached, or when the Compumotor is stopped. How much error is recovered is proportional to load friction and depends on the stick-slip characteristics of the load. The degree of recovery may therefore have to be determined empirically. If using Compumotors or step motors in multi-axis systems, the error under load (if excessive) could be compensated for in the master control system. Decelerating produces a similar error condition as the motor leads the load.

IX. PERIODIC MAINTENANCE

Periodically check the Compumotor mounting bolts and shaft couplings. The ball bearings used in the Compumotor are not sealed but are permanently lubricated and require no maintenance. There are no serviceable items in the Compumotor or maintenance items such as brushes.

The motor strain relief and cable should be inspected at appropriate intervals for signs of wearing or excessive force being applied to the cable. Tighten both cable connectors at the Driver. Check that the Driver heatsink is free of dust and dirt and has a free flow of air over its entire surface.

X. TROUBLESHOOTING

If problems develop in the operation of the Compumotor, refer to the following list of symptoms and causes to identify or localize the problem:

1. Motor Fails to Turn

Probable Causes:

(a) No AC power
(b) Bad connections or bad cables
(c) Tripped or faulty limit switches - make sure that control signals are not being inhibited by limit inputs to a preset indexer or supervisory logic.
(d) Load is jammed - remove AC power from the Driver and verify that the load can be turned manually.
(e) No Step signal coming to Driver - check that a pulse train meeting all requirements for voltage, current and pulse width is available (3.5 to 6V @ mA minimum, 25 mA maximum, 500 nSec pulse width minimum).
(f) Driver output is being turned off by Remote Power Shutdown Option - Pin C of the input cable to the Driver should not be high (TTL level) relative to Pin F.
(g) Blown driver AC line fuse. - Disconnect AC power from the Driver and dismount it from the surface to which it is attached. Remove the four Phillips-head screws which retain the sheet metal cover on the long sides of the Driver. Remove the four screws on the short edges of the end plates. Slip off the cover and inspect the fuse. If the fuse is blown, return the unit for repair.

Notice: Probing of the Driver with AC Power applied should <u>never</u> be done by anyone other than Compumotor qualified personnel. LETHAL VOLTAGES ARE PRESENT and there is no AC line isolation in the Driver.

2. Motor Stops During Acceleration:

Probable Cause:

This condition indicates an overload condition caused by excessive torque requirements, too steep an acceleration ramp, or a gross mismatch of load inertia and rotor inertia. Refer to Compumotor Application Note #3 for calculations of torque. A larger motor and/or lower accelerations may be indicated.

3. Motor Fails to Run Above 20 rps (1200 rpm)

This may be a torque problem but, more likely, it has to do with load/Compumotor interactions which can stimulate parametric oscillations and stall the Compumotor. The addition of friction, system dampening or mechanical redesign to minimize mechanical resonances may be required singly or in combination. Standard Compumotor indexers will not allow a motor velocity above 20 rps (1200 rpm).

4. Motor is Jerky, Noisy or Weak

Check that there are no mechanical problems at the load causing highly variable loading conditions at the Compumotor shaft. Disconnect the Compumotor from the load and run it with a dummy load connected. If the problem persists, service repair is indicated.

X1. FACTORY SERVICE

To return the Compumotor for repair or to order replacement parts, obtain the Model and Serial Numbers of the Motor and Driver. Call the Compumotor Service Department for return authorization. In California call collect: (707) 778-1244, otherwise call toll free (800) 358-9068. Return the Compumotor and Driver, freight prepaid, to:

COMPUMOTOR CORPORATION
1364 North McDowell Boulevard
Petaluma, CA. 94952
Attn: Service Department
RMA # _____

Note: Please mark both packing slip and packing label with the Return Material Authorization number supplied by Compumotor.

XII. FURTHER NOTES

Compumotor Corporation is dedicated to be a leader in digital motion control. We invited your problems, questions or comments.

This manual has been designed to provide an introduction for the user with typical applications. Significant departures from the operating parameters outlined here are possible. If you have a volume requirement for our products (of over 250 per year) we would like to discuss your specific needs.

Call or write:

Technical Marketing Group
Compumotor Corporation
1310 Ross Street
Petaluma, CA. 94952

In California, Call Collect: (707) 778-1244
Outside California, Call Toll Free: (800) 358-9068

XIII. SPECIFICATIONS

Environmental Specifications:

Operating:	Driver - 32-104°F (0-40°C) ambient assumes driver fins mounted vertically, convection cooling. Maximum fin temp. = 150°F (60°) 10 to 90% Humidity, Non-Condensing
	Motor - 32-104°F (0-50°) ambient - assumes convection cooling. Maximum case temp. (measured mid-case) = 230° (110°C) 10 to 90% Humidity, Non-Condensing
Storage:	-40 to 185°F (-40 to 85°C)

Electrical Specifications:

Input power:	105 to 125VAc 50/60 Hz with brownout protection
TTL Inputs:	3.5 to 6.0V pulse height 500 nSec pulse width minimum 20 mA minimum current 1 MHz maximum pulse rate
Driver Dimensions:	See Figure 6.
Driver Weight:	64 oz. (1.81 kg)
Motor Dimensions:	See Figures 1-4
Motor Weight:	See Table

MOTOR SPECIFICATION TABLE

MOTOR SERIES		M57			M83			M106	
MOTOR TYPE		51	83	102	62	93	135	120	178
Rotor Inertia	oz-in^2	0.48	1.28	1.75	3.50	6.70	10.2	21.5	44.0
	Kg-cm^2	.088	.234	320	0.64	1.23	1.87	3.92	8.05
Torque	oz-in	40	80	120	140	260	400	520	700
Motor Case Temp Rise: 1RPS	F°	52	58	54	54	65	61	85	81
	C°	(29)	(32)	(30)	(30)	(36)	(34)	(47)	(45
(Free Air) 5RPS	F°	61	68	63	63	83	80	124	121
	C°	(34)	(38)	(35)	(35)	(46)	(44)	(69)	(67
10RPS	F°	40	54	50	60	74	68	108	106
	C°	(22)	(30)	(28)	(33)	(41)	(38)	(60)	(59
Maximum Driver Temperature Rise		18 (10)	22 (12)	25 (14)	20 (11)	38 (21)	40 (22)	36 (20)	43 (24
Motor Case Dissipation-WATTS									
1 RPS		6	9	11	12	24	27	33	51
5 RPS		7	12	13	15	26	32	48	76
10 RPS		5	8	10	14	24	30	42	67
Max. Driver Input Current - AMPS		0.8	0.9	1.0	1.0	1.3	1.8	2.2	3.0
Motor Weight (with cable)	ozs	23	35	47	57	93	129	135	240
	(kg)	(0.65)	(0.99)	(1.33)	(1.62)	(2.64)	(3.66)	(3.83)	(6.80

APPENDIX A

DUMMY LOAD PARAMETERS

Motor	Inertias		Dummy Load Dimensions for an Aluminum Disc	
	Rotor $(oz\text{-}in^2)$	Dummy Load Approx. $(oz\text{-}in^2)$	Diameter (in)	Thickness (in)
M57-51	0.48	2	4.00	0.063
M57-83	1.28	5	4.75	0.063
M57-102	1.75	7	4.50	0.125
M83-62	3.50	10	4.80	0.125
M83-93	6.70	15	5.30	0.125
M83-135	10.24	25	6.00	0.125
M106-120	21.50	50	7.20	0.125
M106-178	44.00	100	8.50	0.125

Note: These dummy load inertias are arbitrary and do not represent the minimum or the maximum inertias that can be applied to the motor.

APPENDIX B

MINIMUM RECOMMENDED MOTOR/DRIVER WIRE SIZE (AWG)

Motor Series	Maximum Current per Phase (A)	Less Than 100 ft.(20.5M)	100-200 Ft. (30.5-71M)
M57	1	22	20
M83	2	20	18
M106	3	18	16

1. Cable runs of over 200 ft. (71) are not recommended.

2. Voltage drop per motor phase = (cable $\frac{\text{length (A)}}{100}$ x 2) X R

where R = wire resistance in ohms per 100 ft.

Wire Size (AWG)	R (ohms/100 ft)
16	.4
18	.64
20	1.0
22	1.6

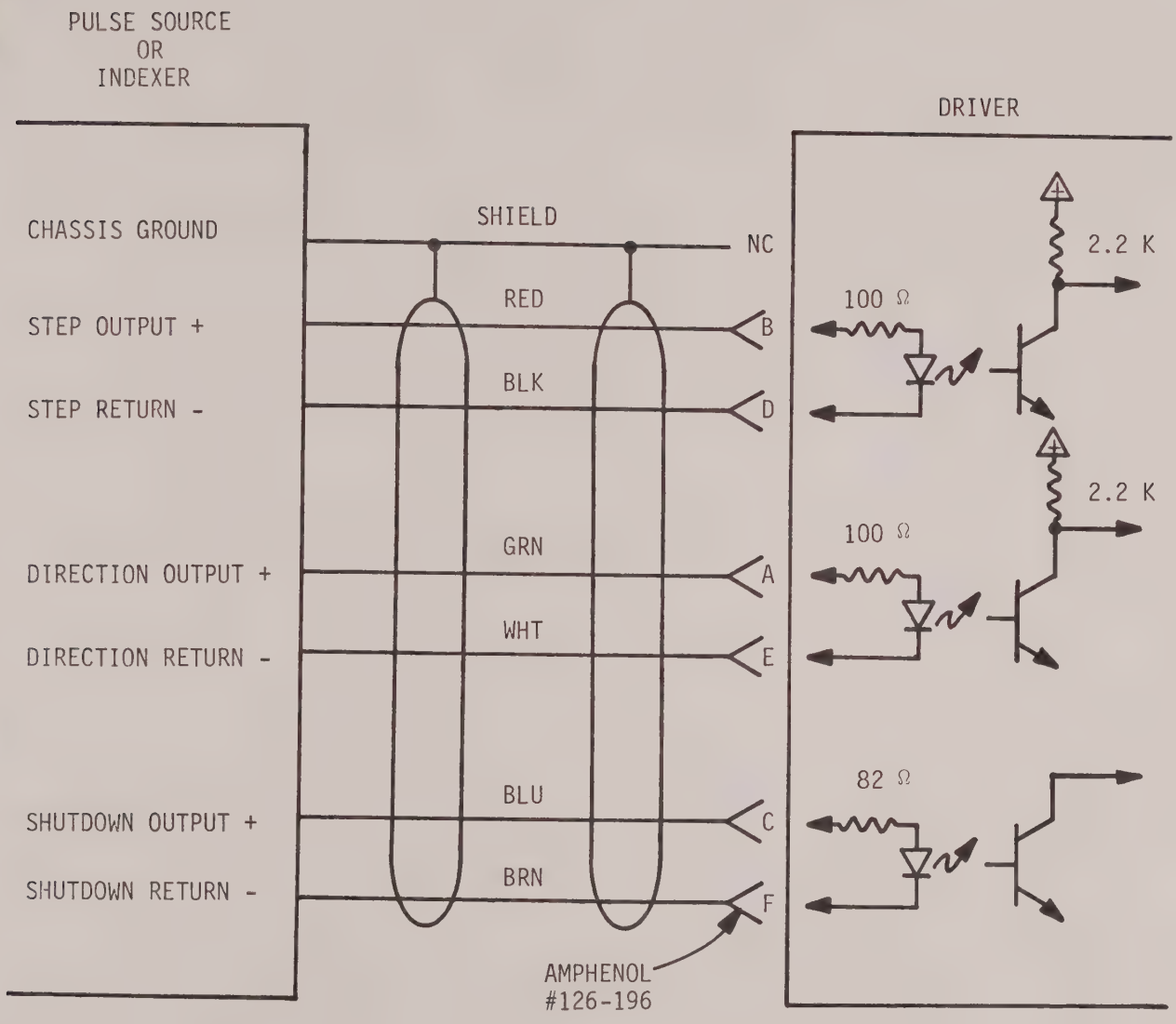
APPENDIX C

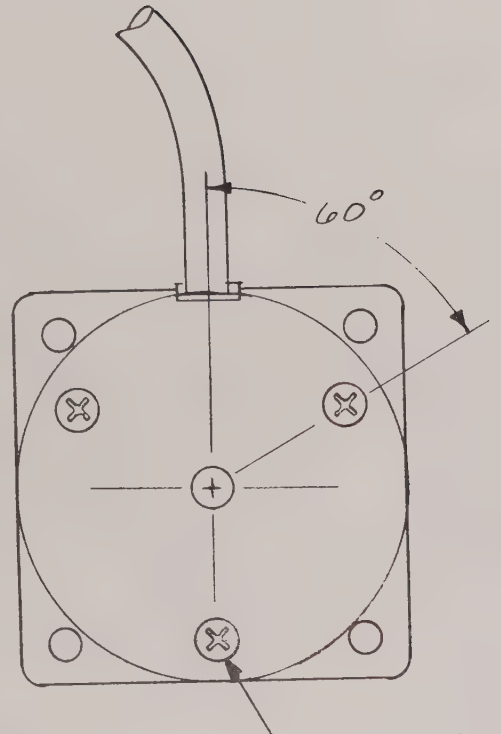
COMPUMOTOR ACCESSORIES

Motor Series	Flexible Coupling P/N	Inertial Damper P/N*	Transformer P/N 117/VAC Isolation	Transformer P/N 230/VAC Step-Down	Rating (VA)
M57	73-000758-01	58-000697	47-000651	47-000654	85
M83	73-000758-11	58-000698	47-000652	47-000655	250
M106		58-000699	47-000653	47-000656	500

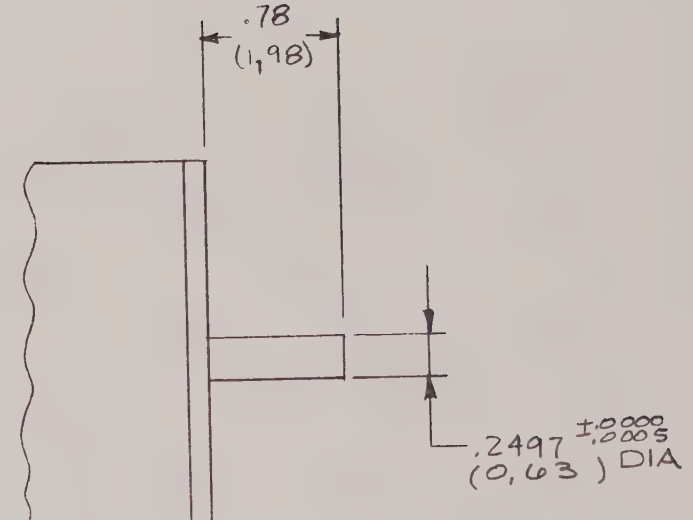
*Double shafted motors only

Consult your Representative, Distributor, or the Factory for price and delivery on these items.


PULSE SOURCE
OR
INDEXER
DRIVER
CHASSIS GROUND
SHIELD
NC
STEP OUTPUT +
RED
B
STEP RETURN -
BLK
D
2.2 K
100 Ω
2.2 K
100 Ω
DIRECTION OUTPUT +
GRN
A
DIRECTION RETURN -
WHT
E
82 Ω
SHUTDOWN OUTPUT +
BLU
C
SHUTDOWN RETURN -
BRN
F
AMPHENOL
#126-196



REAR VIEW

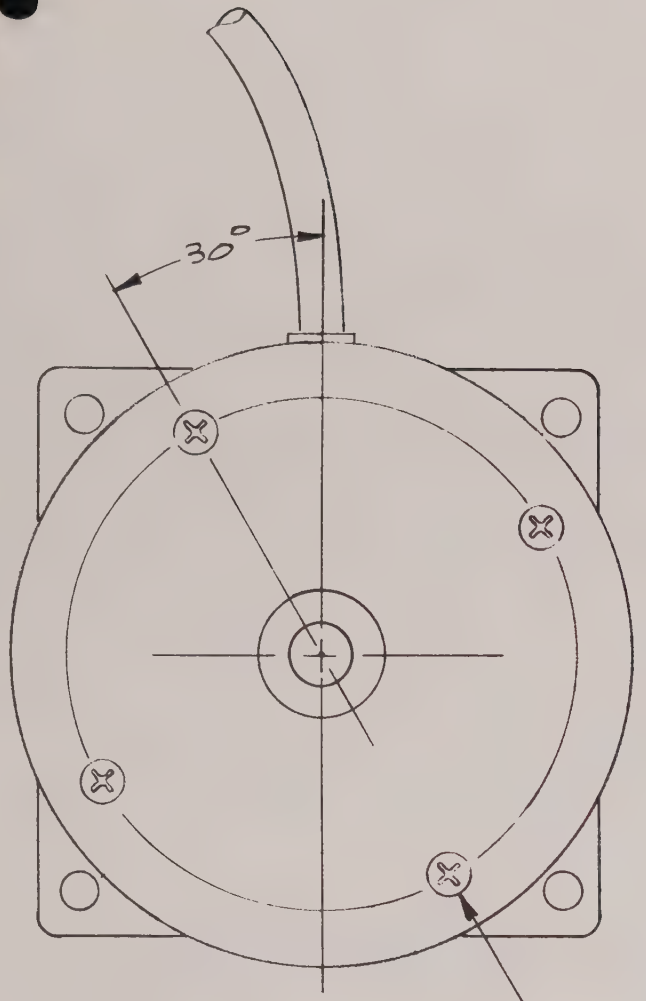


SIDE VIEW

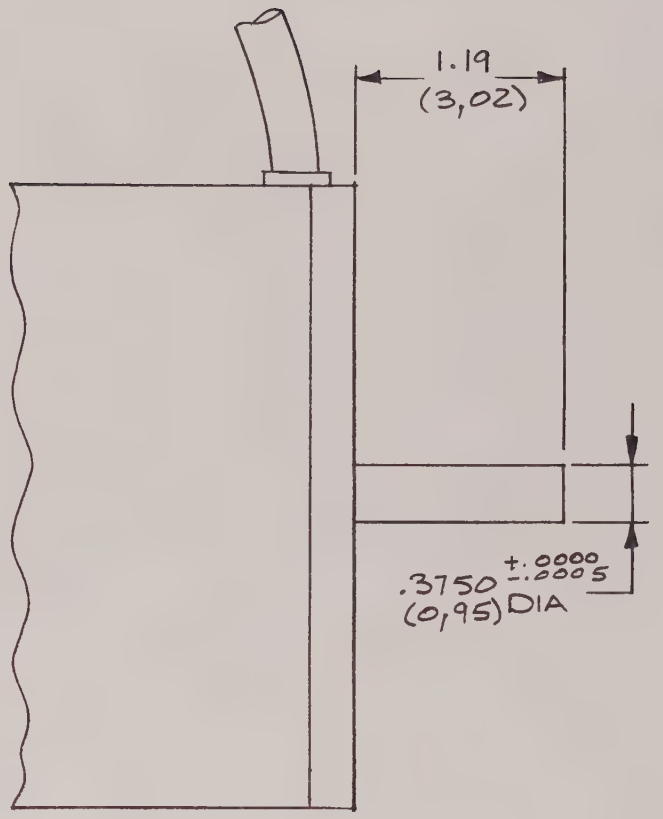
ENCODER MTG HOLES

DIM. DWG.
M 53 SERIES
MOTOR, ENCODER

DWG NO 88-003852-01
REV A



REAR VIEW

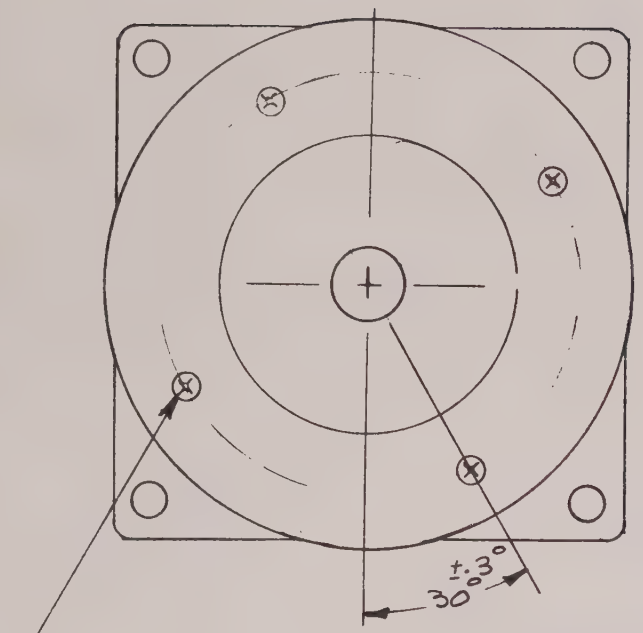


SIDE VIEW

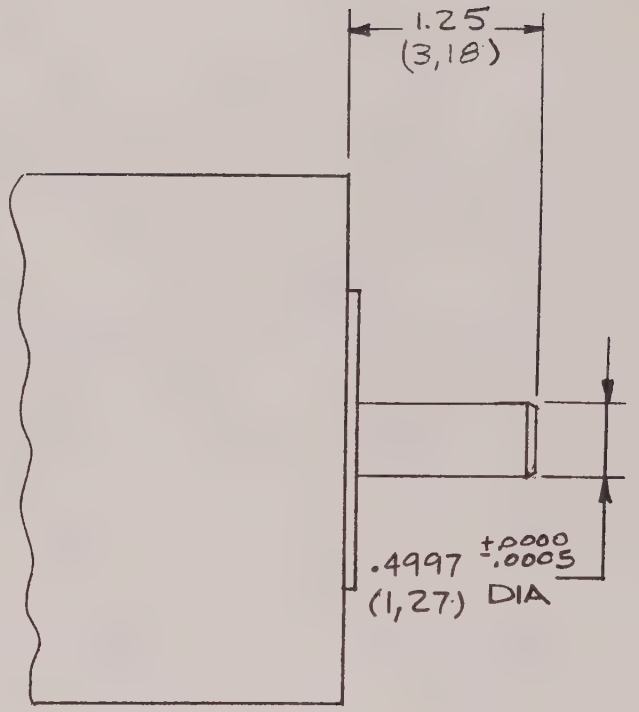
ENCODER MTG HOLES

DIM. DWG.
M 83 SERIES
MOTOR, ENCODER

DWG NO 88-003850-01
REV A



REAR VIEW



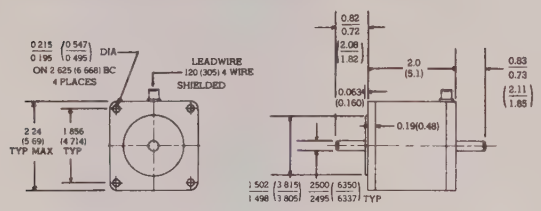
SIDE VIEW

ENCODER MTG HOLES

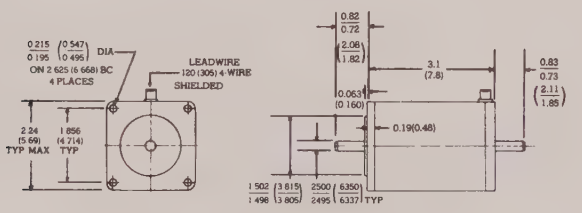
DIM. DWG.
M106-178
MOTOR, ENCODER

DWG NO 88-003854-01
REV A

M57-51 40 OZ-IN (0.30 N-M) STATIC TORQUE



M57-83 80 OZ-IN (0.55 N-M) STATIC TORQUE



M57-102 120 OZ-IN (0.85 N-M) STATIC TORQUE

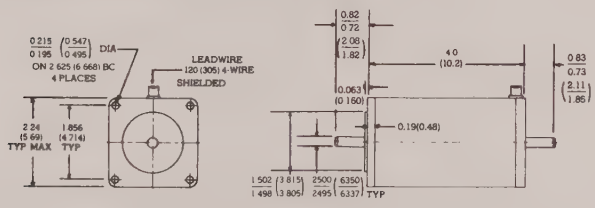
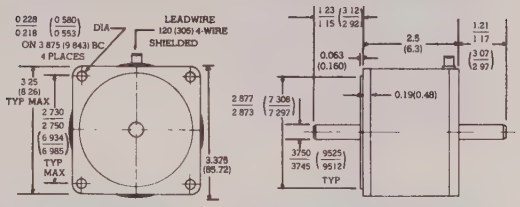
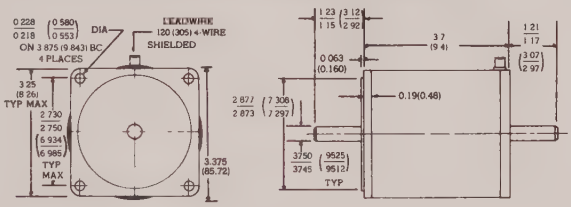


Fig. 1—M57 Series Motor Dimensions

M83-62 140 OZ-IN (1.00 N-M) STATIC TORQUE



M83-93 260 OZ-IN (1.85 N-M) STATIC TORQUE



M83-135 400 OZ-IN (2.80 N-M) STATIC TORQUE

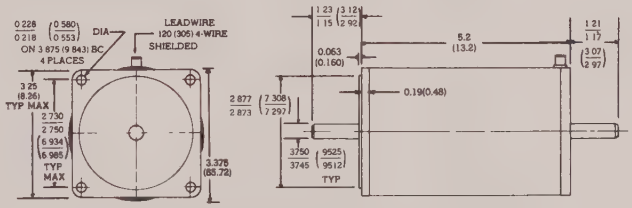


Fig. 2—M83 Series Motor Dimensions

M106-120 525 OZ-IN (3.70 N-M) STATIC TORQUE

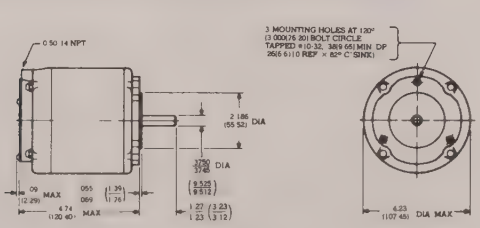


Fig. 3—M106 Series Face Mount

M106-178 700 OZ-IN (4.96 N-M) STATIC TORQUE

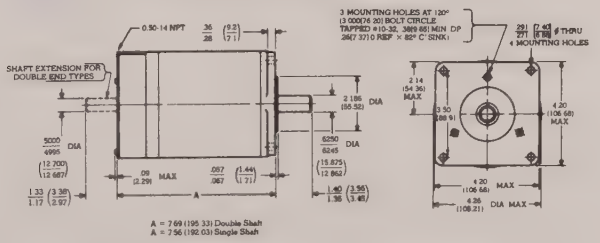


Fig. 4—M106 Series Flange Mount

Fig. 5—Driver with Heatsink Mounted Vertically

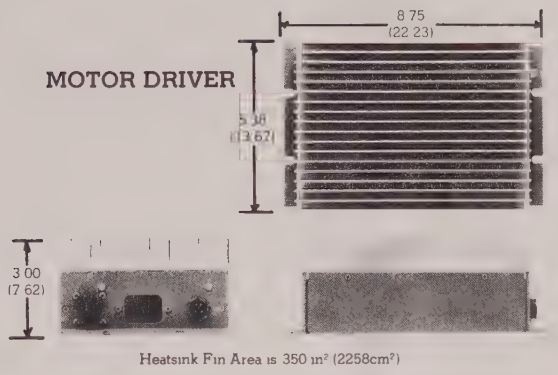


Fig. 6—Driver Dimensions

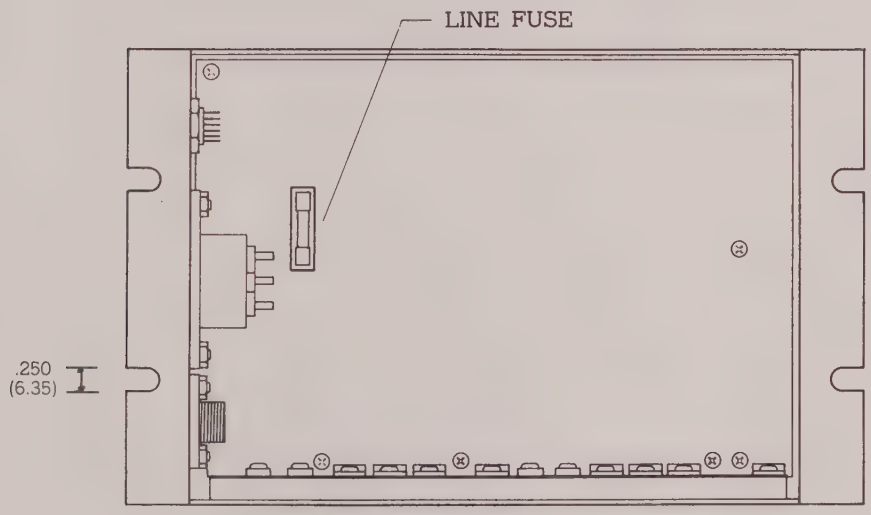


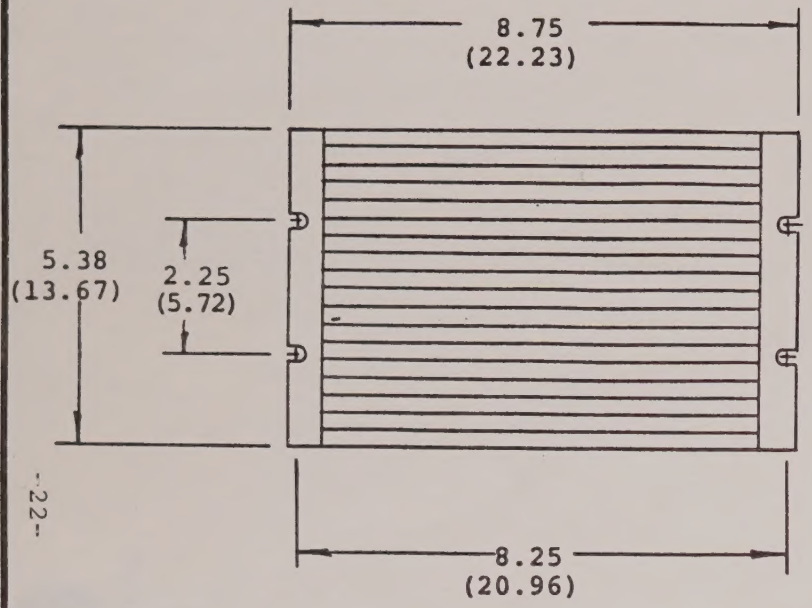
Fig. 7—Line Fuse Location

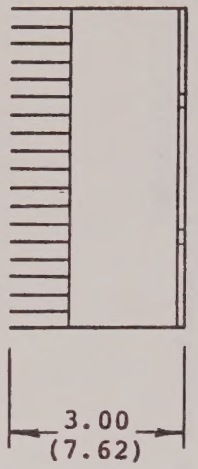
LINE FUSE REPLACEMENT CHART

Motor/Driver	Fuse Rating	Compumotor Part No.	Little Fuse Part No.	Bussman Part No.	Schurter Part No.
M57-51	3A	45-001833-01	212.003	GMA 3	34.1520
M57-83	3A	45-001833-01	212.003	GMA 3	34.1520
M57-102	3A	45-001833-01	212.003	GMA 3	34.1520
M83-62	3A	45-001833-01	212.003	GMA 3	34.1520
M83-93	5A	45-001501-01	212.005	GMA 5	34.1523
M83-135	5A	45-001501-01	212.005	GMA 5	34.1523
M106-120	5A	45-001501-01	212.005	GMA 5	34.1523
M106-178	5A	45-001501-01	212.005	GMA 5	34.1523

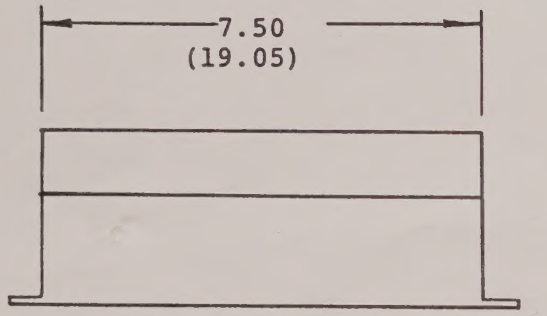
REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	PROD RLS E.R. #134		

APPENDIX F





HEATSINK FIN AREA IS
350 IN^2 (2258 CM^2)



TOLERANCES UNLESS OTHERWISE SPECIFIED		
FRACTIONS	DEC	ANGLES
±	±	±

APPROVALS	DATE
DRAWN	
CHECKED	

COMPUMOTOR CORPORATION

MOUNTING DIMENSIONS
TYPE II DRIVER

SCALE	SIZE	DRAWING NO.
NTS	A	88-001541

DO NOT SCALE DRAWING | SHEET 1

BISHOP GRAPHICS/ACCUPRESS
REORDER NO. A23933

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